Prairie-like Mull Humus, Its Physico-chemical and Microbiological Properties (A Contribution to the Classification of Forest Humus)[1]

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THE prairie-forest transition is a unique geographic region, characterized by its own soil-forming processes and development of peculiar forms of humus. Thus far the existing classifications of forest humus have failed to account for either upland or lowland humus types derived in part from prairie vegetation. This paper reports results of a detailed study of one of the most conspicuous humus forms of the prairie-forest region. This form is distinguished by the enormous depth of the horizon with incorporated organic matter which approaches 2 feet, and is tentatively termed "prairie-like mull."

A concrete example of a prairie-like mull was located in Spring Grove woodland near Monroe, southern Wisconsin. The forest cover of the study area is composed of hard maple with a scattering of basswood, red oak, and white elm. The age of the dominant and codominant trees varies between 120 and 200 years. In all prob-

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TABLE 1.—*Composition of soil profile developed under prairie-like mull humus.*

Horizon and depth, inches	Reaction	Organic matter	Cation exchange capacity	Total N	Available P	Available K	Exchangeable Ca	Exchangeable Mg
	pH	%	ME/100 g.	%	lbs/A	lbs/A	ME/100 g.	
A_1 0–3	7.1	8.0	29.4	0.395	87	380	24.2	5.6
A_1 6–9	6.8	3.0	17.0	0.166	17	187	10.3	2.7
A_1 11–14	6.4	1.9	15.4	0.113	15	96	8.8	2.1
A_1A_2 16–19	6.0	1.5			7	73	7.7	2.0
A_2B 35–38	5.4	1.0			8	35	6.7	1.3
BC 45–48	5.3	0.8	16.9	Tr.	Tr.	22	5.3	1.0

TABLE 2.—*Physico-chemical and microbiological characteristics of prairie, forest, and prairie-like mull soils. (A_1 horizons)*

Type of humus	Reaction	Specific conductance mhos	Redox potential	Oxidized substances	Reduced substances	Average breaking strength	
						Cellulose cord	Protein cord
	pH	10^{-5}	m.v.	mg	mg	kgs	kgs
Prairie humus; Carrington silt loam	7.15	15.5	—137	1.0	14.1	5.7	3.9
Prairie-like mull; Downs silt loam	7.10	8.3	— 51	Tr.	3.6	3.6	2.5
Oak crumb mull; Miami silt loam	6.70	4.8	— 12	3.7	9.3	5.3	1.5

ability, the original cover consisted exclusively of hard maple and basswood, but partial disturbance of the stand about 120 years ago introduced oak and elm. The stand volume averages about 7,500 board feet per acre. The ground cover consists of *Dicentra cucullaria, Claytonia virginica, Erythronium albidum, Parthenocissus vitacea, Sanguinaria canadensis, Podophyllum peltatum, Smilacina racemosa, Amphicarpa monoica, Arisaema atrorubens, Circaea latifolia, Aster* spp., *Desmodium acuminatum, Geranium maculatum, Hepatica acutiloba, Hydrophyllum virginianum, Impatiens pallida, Smilax ecirrhata, Uvalaria grandiflora,* and *Viola* spp.

The morphology of the soil profile, excavated on a gentle slope of about 5% gradient, is as follows:

A_0 Sporadic cover of maple leaves.

A_1 0–15 inches: Zone of humus incorporation. Dark, nearly black silt loam of crumby structure with diffused lower limits, heavily penetrated with roots and inhabited by earthworms, white grubs, ants, and myriapods.

A_1A_2 16–19 inches: Transitional zone. Silt loam of similar structure and appearance except of lighter brownish color.

A_2B 19–35 inches: Humus-impoverished zone. Light brown silty clay loam of coarse blocky structure, penetrated by passages of large roots and practically free of earthworms and insects.

BC 35–48 inches: Zone enriched in mineral colloids. Structureless yellowish-brown silty clay loam, underlain at a greater depth by weathered limestone.

A detailed description of the morphology and the topographic variations of this type, designated in original soil survey as Dodgeville silt loam, is given by A. R. Whitson *et al.* (4). The results of profile analysis are given in Table 1.

The analytical data present a picture seldom observed in forest soils. Contrary to the general trend, the soil gradually changes its reaction from slight alkalinity at the surface to a strong acidity at a depth of 4 feet. This trend of reaction is paralleled by the distribution of replaceable bases. Although the base exchange capacity is strongly influenced by the content of organic matter, its value at an approximate depth of 38 inches indicates a zone enriched in mineral colloids. This enrichment may be either a result of the soil-forming process or the geological make-up of the soil profile.

The content of organic matter and total nitrogen in the surface horizon indicates that the soil is fully comparable to a rich prairie soil or a fully developed chernozem. The analysis shows a very gradual decline in humus with depth, and an appreciable content of organic matter is found as deep as 4 feet. The comparative dearth of available phosphorus and depletion of lower horizons in available potassium suggest a development of soil under cover of grass.

In order to ascertain the genetic nature of the soil profile, a comparison was made between the oxidation-reduction properties (2) and microbiological characteristics (3) of prairie-like mull, true prairie soil (Carrington silt loam), and forest soil degraded by oak forest (Miami series). The results are presented in Table 2. The values of several factors for prairie-like mull are transitional between the two other soils. This strongly indicates that the soil studied was originally prairie soil which underwent only slight modification under the influence of the forest stand.

The changes in chernozem soils caused by invasion of forest cover are well known from the works of Russian pedologists (1). As suggested by a number of Wiscon-

sin studies, prairie soils undergo the same type of metamorphosis (5, 6). However, the general picture of prairie soil degradation was obtained by observations of soils under forest cover of oak, i.e., a species of definite podzol-forming tendencies. Little attention has been given to the composition of prairie soils invaded, not by podzol-forming, but by soil-conserving mesophytic hardwoods. As present observations show, prairie soils under climax cover of hard maple resist the disintegration of incorporated humus and hence remain in a stable equilibrium with the environment. Thus the contention that: "The forest devours black earth" may not be true in all instances.

In dealing with soils of a prairie-like mull type one should always bear in mind the three soil-forming processes which may bring this peculiar type into existence. The most common mode of formation is the invasion of prairie soil by forest cover. The second possibility is the development of a rendzina under sporadic stands of oak on shallow-mantled outcrops of limestone. Finally, the deep humus layer may be a result of water or wind erosion and redeposition of humus material. It should be stressed that the prairie-forest zone is much more exposed to the processes of denudation than is the zone of podzolized soils. Therefore, the combined action of atmospheric and biotic soil-forming factors is to be expected.

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